

Two New Cardinalfishes of the Indo-Pacific Fish Genus *Zoramia* (Apogonidae)

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Two new species of *Zoramia* (formerly a subgenus of *Apogon*) are described. *Zoramia febilis*, described from Fiji, has blue spots on the sides, blue teardrop-shaped marks under the eyes, and two narrow yellow lines on the midside. It also has a small spot surrounded by diffuse melanophores on the caudal peduncle, and lacks an opercular spot and dark vertical lines above the anal-fin rays. It has scattered melanophores on the breast, pelvic fins, and the entire second dorsal fin, and a line of dark pigment along the anal-fin base. There are 27–30 gill rakers, usually 28 or 29. *Zoramia fragilis*, previously thought to range from the Indian Ocean into the Pacific, was shown to consist of two species; *Z. fragilis* restricted to Mozambique, Madagascar, and the Seychelles, and those in the Pacific Ocean a separate species here described as *Z. viridiventer*. These two species are separated by the number of gill rakers and dorsal and anal-fin spine length.

Fraser (1972) divided the apogonid fish genus *Apogon* Lacepède into ten subgenera, mainly on osteological characters. The subgenera *Pristiapogon* and *Zoramia* Jordan were revised by Fraser and Lachner (1985), who recognized four species within *Zoramia* Jordan: *A. leptacanthus* Bleeker, the type species, wide-ranging from the east coast of Africa to the Samoa Islands; *A. fragilis* Smith with a disjunct population, one from Mozambique (type locality), Madagascar, and the Seychelles, and the other from Indonesia and the Philippines to the Marshall Islands and Samoa Islands; *A. gilberti* (Jordan and Seale) from the Philippines, Sabah, and Indonesia, east to Palau and Yap; and *A. perlitus*, described as a new species from Palau, Papua New Guinea, Molucca Islands, and the Philippines.

Rodman-Bergman (2004) reviewed the generic and subgeneric classification of the Apogonidae. Using external morphology, skeletal characters and a detailed study of the cephalic lateralis system, she concluded that *Apogon* is an unnatural taxon: “Every cladogram generated in these analyses showed that the subgenera of these two taxa (*Apogon* and *Pterapogon*) were more closely related to other genera, than they were to one another.” Based on her findings we are treating the subgenus *Zoramia* of Fraser (1972) as a genus.

While conducting a survey of the fishes of Fiji, we collected individuals of a species of *Zoramia* that we did not recognize. The specimens were similar in color to *Z. gilberti*, but lacked the spot on the opercular flap and have distinctive blue teardrop-like marks on the cheek and blue spots on the side of the body above the pectoral fin. In checking comparative material of other species of *Zoramia*, we discovered that the eastern population identified as *Zoramia fragilis* is a

distinct species. The purpose of this paper is to describe these two new species of cardinalfishes. We present first the diagnosis of *Zoramia* based primarily on Fraser and Lachner (1985), followed by a revised key to the species of the genus and the descriptions of the two new species.

MATERIALS AND METHODS

Data for the holotype are presented first, followed by the range and mean or mode for all specimens in parentheses. Measurements were made to the nearest 0.1 mm using dial calipers and are expressed as percentage of standard length (SL). Methods of making counts and measurements follow Fraser and Lachner (1985), except for body depth, which was taken vertically from below the origin of the dorsal fin (their measurement from the origin of first dorsal spine to the insertion of the pelvic spine is slightly oblique). We also added body width (taken just behind the gill opening), predorsal, preanal, and prepelvic lengths, lengths of dorsal- and anal-fin bases, and caudal concavity, the horizontal distance between the tips of the longest and shortest caudal rays. A microscope is needed to see scattered melanophores described in the key for *Z. flebila*.

The spines and especially the soft rays of the fins of the species of *Zoramia* are very fragile and often found broken. It is unusual to have a specimen with fully intact fins among older lots of museum specimens. Longest caudal-fin ray and caudal concavity measurements of the holotypes were taken from photographs in the field before fin rays were broken. The third dorsal-fin spine is broken in the holotype of *Z. flebila*. Lateral-line scales often are lost. Eye size as percentage standard length versus standard length for *Z. flebila* and *Z. gilberti* was tested with a two-sample T-test (Fig. 3). Specimens used in figure two were from both some of the types and also CAS 2223156. Except for *Z. flebila*, *Z. viridiventer*, and *Z. fragilis*, gill raker counts in Table 2 are from Fraser and Lachner (1985). Measurements for *Z. viridiventer* were taken from nine BPBM specimens. Specimens of the new species have been deposited in the Australian Museum, Sydney (AMS); Natural History Museum, London (BMNH); Bishop Museum, Honolulu (BPBM); California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); University of Kansas (KU); National Science Museum, Tokyo (NSMT); South African Institute for Aquatic Biodiversity, Grahamstown (SAIAB); and the U.S. National Museum of Natural History, Washington, D.C. (USNM).

Genus *Zoramia* Jordan, 1917

Zoramia Jordan, 1917: 46 [type species *Apogon graeffi* Günther, 1873, by original description (also monotypic) = *Apogon leptacanthus* Bleeker, 1856].

DIAGNOSIS.— Dorsal rays VI-1,9; anal rays II,9; pectoral rays 13-15 (usually 14); pelvic rays I,5; scales finely ctenoid; lateral line complete to caudal-fin base, the pored scales 23-24; median predorsal scales 6; scales of body not smaller than lateral-line scales; gill rakers 24-32; branchiostegal rays 7; vertebrae 10 + 14; supraneural (predorsal) bones 3; mouth very oblique, the lower jaw strongly projecting; supramaxilla absent; posterior end of maxilla with a distinct notch; maxilla with a longitudinal ridge ending just before angle of posterior notch; jaws with two rows of very small conical teeth anteriorly, narrowing to one row posteriorly; a single row of very small teeth on vomer and palatines, none on ectopterygoids; preopercular ridge smooth, the edge finely serrate, becoming smooth dorsally on posterior limb; infraorbital edge smooth; posttemporal smooth; body depth moderately deep, 2.1-4.0 in standard length (juveniles more slender, in general), and strongly compressed, the maximum width 2.5-3.4 in body depth; caudal fin moderately forked; no black stripes (though there may be a dark line along dorsal edge of body); digestive tract black.

Key to the Species of *Zoramia*

- 1a. No black spot on caudal peduncle; second dorsal spine very long and filamentous, 34–66% SL (at SL of 23 mm or more), the third and fourth spines also prolonged (east coast of Africa to Samoa Islands) *Z. leptacantha* (Fig. 1A)
- 1b. A small black spot midposteriorly on caudal peduncle; second dorsal spine not very long and filamentous (except adults of *Z. flebila* and *Z. gilberti*, but spine length less than 36% SL). 2
- 2a. A prominent to diffuse dark spot posteriorly on opercle; total gill rakers 28–32 (Philippines, Indonesia, and western Caroline Islands) *Z. gilberti* (Fig. 1B)
- 2b. No dark spot posteriorly on opercle; total gill rakers 24–30. 3
- 3a. Four to eight short vertical dark lines above anterior half of anal-fin (Philippines, Indonesia, Papua New Guinea, and Palau. *Z. perlita* (Fig. 1F)
- 3b. No vertical dark lines above anal-fin base. 4
- 4a. Basicaudal black spot surrounded by a dusky to blackish zone; entire second dorsal fin, breast, and pelvic fins with scattered melanophores (microscope needed); a line of melanophores running along anal-fin base on body; second dorsal-fin spine 21.8–35.2% SL; body depth usually greater than 40% SL (Fiji) *Z. flebila*, sp. nov. (Fig. 1C, 2)
- 4b. Basicaudal black spot not within a dusky to blackish zone on caudal peduncle; posterior half of second dorsal fin, breast, and pelvic fins lacking scattered melanophores; no line of melanophores running along anal-fin base on body; second dorsal-fin spine 18.9–24.8% SL; body depth usually less than 40% SL 5
- 5a. Gill rakers 27–30; second dorsal-fin spine 21.5–24.8% SL; second anal-fin spine 15.1–17.9% SL (Mozambique, Madagascar, and Seychelles) *Z. fragilis* (Fig. 1D)
- 5b. Gill rakers 24–27; second dorsal-fin spine 18.9–21.7% SL; second anal-fin spine 13.0–15.9% SL (Philippines to Queensland, east to Marshall Islands and Samoa Islands) *Z. viridiventer*, sp. nov. (Fig. 1E, 4–6)

SPECIES DESCRIPTIONS

Zoramia flebila Greenfield, Langston, and Randall, sp. nov.

Figs. 1C, 2, Tables 1–2.

MATERIAL EXAMINED.—**HOLOTYPE:** CAS 222057, 40.2 mm SL, Fiji, Northern Lau Group, Vanua Balavul Island, Bay of Islands, 17°10.692'S, 179°00.887'W, sand with small coral patch, 8.3 m, 7 January 2003, field number G03-22, collected by D. W. Greenfield, K. R. Longenecker, and R. C. Langston. **PARATYPES:** BPBM 40152, 38.4 mm SL, collected with holotype; USNM 383148, 35.1 mm SL, collected with holotype; CAS 222155, 34.6–39.5 mm (3), Fiji, Vanua Levu, north shore, Great Sea Reef, southwest of Kia Island, 16°18.591'S, 179°02.129'E, isolated coral head in fine sand, 10.8–11.5m, 27 March 2002, field number G02-109, collected by D. W. Greenfield, K.R. Longenecker, R. C. Langston, and B. K. Mataitini; FMNH 116455, 43.6 mm, collected with CAS 222155; BM(NH) 2005.4.25.1, 39.3 mm, collected with CAS 222155; AMS I.43576-001, 36.4 mm, collected with CAS 222155; NSMT-P70721, 41.5 mm, collected with CAS 222155; SAIAB 75633, 36.1 mm, collected with CAS 222155; BPBM 40153, 33.3 mm, collected with CAS 222155; USNM 383149, 40.4 mm, collected with CAS 222155. **ADDITIONAL MATERIAL EXAMINED:** *Zoramia flebila*, CAS 222156 (112), CAS 219847 (1 –DNA = 4024), KU 31970 (1–DNA = 4020), all collected with paratypes CAS 222155. *Zoramia gilberti*: Western Caroline Islands, Yap Island, CAS 83496 (50), CAS 28780 (40), CAS 28780 (1), Palau, CAS 85911 (4). *Zoramia viridiventer*: Solomon Islands, CAS 167414 (9). *Zoramia leptacantha*: Yap Island, CAS 84415 (2), Palau, CAS 84399 (2), Fiji, CAS 222157 (39). *Zoramia*

perlita: Palau, CAS 30740 (5) paratypes, CAS 30745 (1) paratype. *Zoramis fragilis*: Madagascar, USNM 211839 (9).

DIGANOSIS.— A species in the genus *Zoramia* with no distinct dark line on the dorsum from the first dorsal-fin origin onto the caudal peduncle; no dark lines above insertion of anal-fin rays; opercular flap lacking a prominent or diffuse dark spot; caudal spot small, surrounded with many diffuse melanophores on caudal peduncle; a peppering of melanophores on the breast and pelvic fins, and all of the second dorsal fin; distinct blue teardrop-like marks on cheek; blue spots on side above pectoral fin; two narrow yellow lines on midside; an iridescent blue line along anal-fin base; total developed gill rakers 27–30, usually 28 or 29; second dorsal-fin spine 21.8–35.2 % SL; body depth 39.7–47.2% SL.

DESCRIPTION.— Dorsal-fin elements VI–I, 9; anal-fin elements II,9 last dorsal and anal-fin rays branched to base; pectoral-fin rays 13 (13–14, usually 14), uppermost two and lower two or three unbranched; pelvic-fin rays I,5, all branched; principal caudal-fin rays 17, upper and lower unbranched; well-developed gill rakers 21 + 7 (21–23, usually 22 + 6–7, usually 6, total 27–30, usually 28 or 29); pored lateral-line scales 24; transverse scale rows above lateral line 2; median predorsal scales 6; circum-peduncular scales 12.

Proportions (as percent SL; also see Table 1): Body depth 47.2 (39.7–47.2; 44.1); head length 39.7 (38.1–41.8; 40.0); eye length 14.8 (14.4–15.7; 15.2); snout length 9.8 (6.8–9.8; 7.9); bony interorbital width 8.8 (8.4–9.7; 9.2); upper jaw length 18.9 (17.7–20.3; 18.8); caudal-peduncle depth 17.1 (15.4–19.0; 16.8); caudal-peduncle length 23.0 (18.8–28.5; 24.6); predorsal-fin length 37.3 (36.6–41.2; 38.9); base of first dorsal fin 19.0 (14.9–19.0; 17.4); dorsal-spine lengths—first 10.1 (10.1–14.8; 12.4), second 35.2 (21.8–35.2; 27.3), third [broken in holotype, not measured] (19.0–23.2; 21.9), fourth 21.0 (16.6–23.6; 19.7), fifth 15.5 (11.5–15.7; 13.6), sixth 8.1 (6.8–9.2; 8.0); base of second dorsal fin 20.6 (17.4–24.5; 21.6); spine in second dorsal fin 14.9 (14.9–21.1; 18.0); longest dorsal ray 26.6 (26.6–29.2; 28); preanal length 60.1 (55.4–63.9; 60.6); base of anal fin 23.7 (20.3–24.0; 22.4); anal-spine lengths—first 4.8 (4.3–5.8; 4.9), second 13.0 (13.0–16.2; 14.9); longest anal ray broken (25–27.5; 26.5); pectoral-fin length

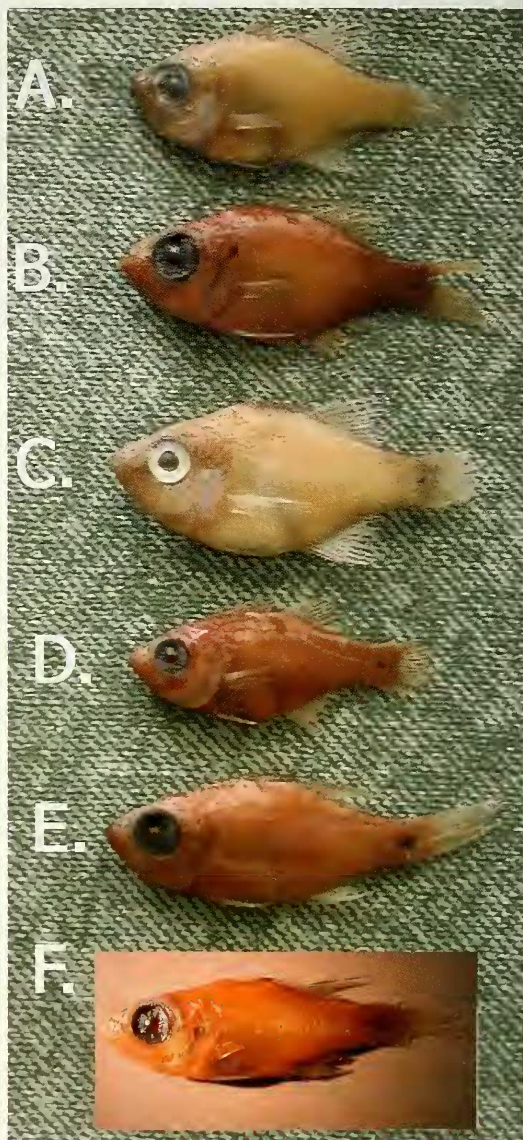


FIGURE 1. Preserved *Zoramia* specimens: 1A: *Z. leptacantha*, CAS 222157; 1B: *Z. gilberti*, CAS 85914; 1C: *Z. flebila*, CAS 222057 (Holotype); 1D: *Z. fragilis* USNM211839; 1E: *Z. viridiventer*, CAS84689; 1F: *Z. perlita*, CAS30740 (Paratype).

28.3 (24.8–31.1; 26.1); prepelvic length 31.8 (31.2–41.0; 35.4); pelvic-fin spine 15.1 (15.1–20.8; 18.3); pelvic-fin length 26.1 (24.6–30.0; 26.2).

Body depth 2.1 (2.1–2.5) in SL; body compressed, the width 2.8 (2.8–3.4) in body depth; dorsal profile of head straight; snout length 4.0 (4.0–5.9) in head length; orbit diameter 2.7 (2.5–2.8) in head length; bony interorbital width 4.5 (4.1–4.7) in head length; caudal-peduncle depth 2.3 (2.1–2.7) in head length; caudal-peduncle length 1.7 (1.4–2.3) in head length.

Mouth very oblique, forming an angle of about 50° to horizontal axis of head, the lower jaw strongly projecting; maxilla extending to below center of eye, the upper-jaw length 2.1 (1.9–2.4) in head length; posterior end of maxilla with a distinct angular notch; dentition as in the genus. Tongue narrowly triangular with rounded tip, the upper surface with small papillae. Gill rakers well developed, the longest on lower limb nearly half orbit diameter in length. Anterior nostril a small, short, membranous tube on side of snout, slightly more than half distance from fleshy edge of orbit to median anterior point of upper lip; posterior nostril a narrow elliptical opening at level of upper edge of pupil, its length about one-fourth pupil diameter.

Suborbital margin smooth, ending below center of eye; preopercular ridge smooth; posterior three-fourths of ventral edge of preopercle and ventral one-quarter of posterior edge finely serrate.

Color of fresh specimen: Top of head and back greenish gray, overlaid with scattered, small melanophores. Two parallel, narrow, yellow lines running along midside from opercle to caudal peduncle. Area below yellow lines lighter than dorsum, silvery under pectoral fins and on belly, a bluish tinge on area above anal fin. Scattered bluish spots above pectoral fin, overlaying yellow lines. Caudal peduncle with heavy concentration of melanophores, forming a dark band at caudal-fin base. A small black spot at center of band. Area below eye, preopercle and opercle silvery, extending back to join silvery belly. Four relatively large teardrop-shaped blue marks under and behind eye, with several more spots extending up along opercular margin. Snout dark green, tip of lower jaw with reddish tinge. Pupil of eye black, iris silvery with a greenish band running horizontally across it at pupil. First two dorsal-fin spines with a reddish tinge, remainder of dorsal fin greenish yellow. Pelvic fins reddish. Caudal fin clear except for greenish dorsal and ventral margins at base. Anal fin clear with a black band along its base and an iridescent blue line next to it on the body. Pectoral fins clear. Often coloration that is blue in life may turn a pink color after the fish is dead but still fresh, thus the color in Figure 2 looks pink. Another photograph of the two DNA specimens shows a blue color.

Color in alcohol: Head and body straw yellow. Top of head and sides of body, except area under and below pectoral fin, covered with tiny, scattered melanophores. Melanophores more concentrated on caudal peduncle, forming a band. A small black spot about half a pupil diameter centered on side of band. Area under eye, preopercle and opercle lacking pigment. Snout and lower jaw with scattered melanophores. Area between isthmus and insertion of pelvic fins with scattered melanophores. Pupil of eye dark, surrounded by silvery iris. First and second dorsal, caudal, and pelvic fins covered with scattered melanophores. Anal fin clear except for a row of melanophores along its base. Pectoral fins clear.



FIGURE 2. Holotype of *Zoramia flebila*, CAS 222057.

TABLE 1. Proportional measurements of type specimens of *Zorania fleabila* as percentage of standard length.

	Holotype		Paratypes										
	CAS 222057	CAS 222155	CAS 222155	CAS 222155	BPBM 40152	BPBM 40153	BM(NH) 2005.4.25.1	USNM 383149	USNM 383148	FMNH 116455	AMS 1.43576-001	NSMT P70721	S/AlAB 75633
Standard length (mm)	40.2	34.6	36.4	39.5	38.4	33.3	39.9	40.4	35.1	43.6	36.4	41.5	36.1
Body depth	47.2	39.7	45.3	46.2	45.9	42.8	45	46.3	40.7	45.6	41.2	44.3	43.5
Body width	16.9	13.7	14.8	13.9	14.9	14.9	14.4	15.1	14.7	14.7	13.3	15.5	12.7
Head length	39.7	39.7	40.3	40.6	38.1	38.6	41.8	38.7	39.6	41.4	38.9	41.4	41.4
Snout length	9.8	7.5	8.1	6.8	8.1	7.8	8	7.3	8	7.1	8.2	7.6	8.4
Orbit diameter	14.8	15.6	15.1	15.6	14.7	15.3	15.3	15.3	15.2	15.6	14.8	15.7	15.5
Interorbital width	8.8	8.4	8.6	9	9.1	9.6	9.5	9.4	9.3	9.6	9.2	9.6	9.7
Upper-jaw length	18.9	17.8	19.6	18	17.9	18.5	18.9	20.2	17.7	19.9	18.7	19.4	18.8
Caudal-peduncle depth	17.1	15.6	16.7	17	18.2	17.3	17.4	16	16.1	16.3	16.5	16.7	15.4
Caudal-peduncle length	23	28.5	26.1	25.1	26	26	26.4	16.6	20.2	24.4	26.2	22.3	26.9
Predorsal length	37.3	36.6	39.5	39.2	37.2	40.2	38.8	41.2	37.7	40.9	39.1	39.6	37.9
Base of first dorsal fin	19	18.2	18.1	14.9	18.2	16.1	18.3	14.6	16.1	16.5	17.9	17.3	16.3
First dorsal-fin spine	10.1	12.1	14.8	13.3	13.3	10.5	broken	12.4	broken	Broken	11.4	13.7	13.7
Second dorsal-fin spine	35.2	broken	broken	22.7	29.6	21.8	25.1	31.2	broken	24.6	27.5	broken	28.2
Third dorsal-fin spine	broken	broken	broken	24.9	19	broken	23.2	21.5	broken	Broken	19.9	broken	22.7
Fourth dorsal-fin spine	21	broken	23.6	17.7	21.5	18.3	broken	19.8	broken	Broken	19	broken	16.6
Fifth dorsal-fin spine	15.5	broken	broken	15.7	14	13.2	14	11.5	12.7	Broken	14.4	12.3	13
Sixth dorsal-fin spine	8.1	broken	9.2	8.6	7.4	7.9	7.3	4.9	6.8	8.1	8.2	8.9	broken
Base of second dorsal fin	21	20.6	23.4	24.5	20	21.9	20.9	23.3	21.1	19.2	21.3	23	17.4
Second dorsal-fin spine	14.9	broken	21.1	19.5	16.6	18.3	18.5	broken	16.5	16.2	19.5	17.6	19.1
Longest dorsal ray	26.6	27.2	29.2	broken	broken	28.7	28.3	broken	broken	Broken	broken	broken	broken
Prenal length	60.1	60.2	63.8	61.2	61.6	55.4	60.8	63.9	57.8	61.5	60.2	59	62.6
Base of anal fin	23.7	22.7	23.4	23.3	21.3	22.2	22.2	20.3	22.2	22.7	24	22.2	20.9
First anal-fin spine	4.8	5.2	5.8	4.8	4.8	5.4	4.4	4.4	4.3	4	4.8	5.8	5
Second anal-fin spine	13	13.9	16.2	16.2	14.6	15.6	15.4	15.3	14.7	13.6	15.4	14.9	15.2
Longest anal ray	broken	27	broken	27.1	25	25.5	27	broken	broken	Broken	27.5	broken	broken
Caudal-fin length	33.2	broken	broken	broken	broken	broken	broken	broken	broken	Broken	broken	broken	broken
Caudal concavity	7.6	broken	broken	broken	broken	broken	broken	broken	broken	Broken	broken	broken	broken
Pectoral-fin length	28.3	30.8	30.2	31.1	27.8	28.5	28.9	29.2	26.5	29.4	28.3	27.7	30.5
Prepelvic length	31.8	31.3	37.3	37	31.2	35.6	36.6	38	32.8	37	33.6	36.9	41
Pelvic spine	15.1	17.5	17.6	19	15.6	15.6	20.2	20.8	17.1	18.8	19.5	17.1	18.3
Pelvic-fin length	26.1	24.8	26.4	30	26.8	25.5	26.4	26.2	24.6	26.4	25.1	27.1	25.9

ETYMOLOGY.— The specific epithet is an adjective from the Latin *flebilis* (tearful), referring to the teardrop-shaped marks on the cheek.

COMPARISONS.— *Zoramia flebila* differs from *Z. leptacantha* by lacking the dark line on the dorsum from the origin of the first dorsal fin onto the caudal peduncle. It also has a caudal spot that *Z. leptacantha* lacks. It differs from *Z. perlita* by lacking the dark lines just above the insertion of some of the anal-fin rays. It differs from *Z. gilberti* by lacking either a prominent or diffuse dark spot on the opercular flap, and by having a significantly ($T=-4.14$, $P=0.000$, $DF=28$) smaller eye (Fig. 3). It differs from *Z. fragilis* and *Z. viridiventer* by having diffuse melanophores on the caudal peduncle in addition to a small caudal spot,

by usually having scattered melanophores on the breast, pelvic fins, and posterior part of the second dorsal fin that are lacking in *Z. fragilis* and *Z. viridiventer*. It also has a line of dark pigment along the anal-fin base that is lacking in both species. Whereas *Z. fragilis* and *Z. viridiventer* usually have black tips on the caudal fin, there is no such coloration in *Z. flebila*. The body is deeper (39.7–47.2: 44.1 % SL) in *Z. flebila* than in *Z. viridiventer* and *Z. fragilis* (usually less than 40% SL). *Zoramia flebila* differs from all described species by its distinctive coloration. For a comparison of gill-raker counts, see Table 2.

Two DNA tissue samples, 4020 and 4024, are deposited at the University of Kansas. The voucher specimens for these samples are 4024 = CAS 219847, and 4020 = KU 31970.

***Zoramia viridiventer* Greenfield, Langston and Randall, sp. nov.**

Figs. 1E, 4–6; Tables 2–3.

Apogon fragilis (non Smith) Burgess and Axelrod, 1975:1442, lower fig. (Madang, Papua New Guinea).

Apogon gilberti (non Jordan and Seale) Hayashi, 1980:263, fig. 2 (Ishigaki, Okinawa Prefecture).— Hayashi and Kishimoto, 1983: 36, fig. 39 (Iriomote Island).

Apogon fragilis (non Smith) Russell, 1983:49 (One Tree Island, Capricorn Group, southern Great Barrier Reef).— Wass, 1984:13 (American Samoa).— Fraser and Lachner, 1985:43, fig. 1 (Indonesia to Samoa Islands).— Eichler and Myers, 1997:136, lower fig. (Ryukyu Islands, Marshall Islands and southern Great Barrier Reef).— Okamura and Amaoka, 1997:302, lower right fig., 303 (Amami O Shima Islands).— Myers, 1999:130, pl. 53, fig. C (Palau and southern Marshall Islands).

Zoramia fragilis (non Smith) Randall, 2005:215, middle fig. (western Pacific east to Marshall Islands and Samoa).

TABLE 2. Total gill-raker counts for species of *Zoramia*. Counts are from Fraser and Lachner (1985), except for *Z. flebila*, *Z. fragilis*, and *Z. viridiventer*.

	24	25	26	27	28	29	30	31	32
<i>Z. flebila</i>					8	12	12	1	
<i>Z. fragilis</i>					1	7	28	2	
<i>Z. gilberti</i>						10	27	19	7
<i>Z. leptacantha</i>						5	19	18	11
<i>Z. perlita</i>				3	18	26	7		
<i>Z. viridiventer</i>	3	24	26	5					

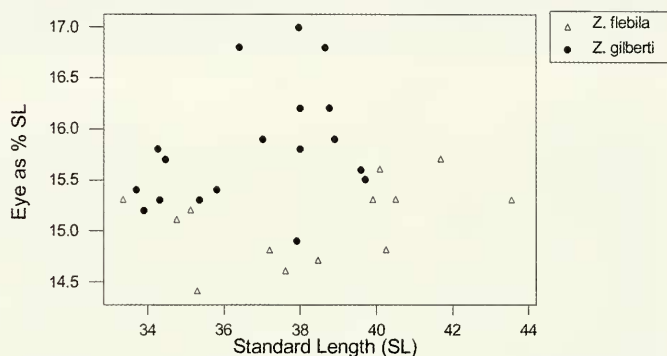


FIGURE 3. Eye diameter as percentage standard length versus standard length. *Zoramia flebila* open triangles, *Z. gilberti* closed circles.

MATERIAL EXAMINED.— Holotype: BPBM 32507, 39.2 mm, Papua New Guinea, Madang Province, lagoon side of Pig Island (Tab Island), coral patch in 17 m, rotenone, J.E. Randall and P.L. Colin, 3 November 1987. Paratypes: CAS 222277, 10: 32.5–40.0 mm, Caroline Islands, Pohnpei, Tokoteihi, inner reefs bordering lagoon west of pass, depth to 4.5 m, rotenone, R.R. Rofen et al., 1 July 1954; CAS 222278, 8: 35.0–38.0 mm, Vanuatu, Espiritu Santo, Palikulo Bay, isolated coral head surrounded by sand, 0.5–4 m, rotenone, R.L. Bolin and R. Persson, 7 October 1958; BPBM 8071, 35: 24.5–36.6 mm, Palau, limestone islet southwest of Urukthapel, fringing reef, 9 m, rotenone, J.E. Randall and E.S. Helfman, 11 June 1968; BPBM 9699, 4: 27.0–31.7 mm, Marshall Islands, Majuro Atoll, lagoon, 2 m, quinaldine, J.E. Randall and A.R. Emery, 30 March 1970; AMS I.17086-009, 10: 33.5–38 mm, Papua New Guinea, Madang Harbor, Paeowai Island, 5°11'S, 145°51'E, 9–11 m, B.B. Collette and party, 25 May 1970; BPBM 15627, 11: 31.5–36.2 mm, Solomon Islands, Alite Reef (off Malaita), lagoon coral head, 3 m, rotenone, J.E. Randall and G.R. Allen, 25 July 1973; BPBM 15684, 25.9 mm, Solomon Islands, Guadalcanal, Honiara Yacht Harbor, patch reef on mud bottom, 14 m, rotenone, J.E. Randall and B. Goldman, 2 August 1973; AMS I.18272-002, 45.0 mm, Australia, Great Barrier Reef, Capricorn Group, One Tree Island, lagoon, R.H. Kuiter, 20 September 1974; BPBM 19220, 4: 33.4–41.3 mm, Indonesia, Molucca Islands, Ambon, Ambon Bay, Poka, adjacent to wreck of ship near dock; silty bottom with iron wreckage, 15 m, rotenone, J.E. Randall and G.R. Allen, 16 January 1975; AMS I.20976-008, 10: 34.5–40.0 mm, Australia, Great Barrier Reef, Lizard Island, off Mrs. Watson's Beach, 10–11 m, D.F. Hoese and H.K. Larson, 24 November 1978; AMS I.43600-001, 3: 37.2–38.5 mm, BMNH 2005.5.10.1-3, 3: 39.2–40.0 mm, BPBM 40155, 6: 33.9–42.3 mm, NSMT-P 70846, 3: 37.9–38.5 mm, SAIAB 75547, 3: 37.1–38.3 mm, all with same data as holotype; BPBM 39077, 2: 26.5–31.3 mm, Papua New Guinea, New Britain, Kimbe Bay, reef off Walindi Plantation, drop-off among branches of sponge, 16 m, quinaldine, J.E. Randall and J.L. Earle, 21 August 2002.

DIAGNOSIS.— A species of *Zoramia* with only the following dark markings: a small black spot midposteriorly on caudal peduncle one-half pupil diameter or more in size; a faint broad dusky band on side of snout directly before eye; some specimens with a faint dusky line at base of dorsal fins; tips of one or both caudal lobes often blackish; second dorsal-fin spine 18.9–21.7% SL; second anal-fin spine 13.0–15.9% SL; gill rakers 24–27 (rarely 27).

DESCRIPTION.— Dorsal-fin elements VI-1.9; anal-fin elements II.9; last dorsal-fin and anal-fin rays branched to base; pectoral-fin rays 14, uppermost and lower two or three unbranched; pelvic-fin rays I.5, all branched; principal caudal-fin rays 17, upper and lower unbranched; lateral-line scales to caudal-fin base 24 (plus one smaller pored scale extending onto base of fin); two near-equal scales above lateral line to base of first two dorsal-fin spines, followed by a series of large scales in a single row below remaining spines and second dorsal fin, these scales overlapping all but narrow upper part of scales below; scales below lateral line to origin of anal fin 5; predorsal scales 6; circumpeduncular scales 12; total gill rakers on first gill arch 6 + 26 (6–7 + 24–27), only one with 7 rakers on upper limb (raker at angle included in lower count).

Body depth 2.6 (2.55–3.3) in SL (specimens less than about 34 mm progressively more slender); body very compressed, the width 2.8 (2.65–2.8) in body depth; head length 2.55 (2.4–2.55) in SL; dorsal profile of head straight; snout length 3.9 (3.95–4.2) in head length; orbit diameter 2.65 (2.6–2.8) in head length; bony interorbital width 4.45 (4.1–4.65) in head length; caudal-peduncle depth 2.4 (2.5–2.75) in head length; caudal-peduncle length 1.6 (1.55–1.7) in head length. (See also Table 3 for additional porportional measurements.)

Mouth very oblique, forming an angle of about 50° to horizontal axis of head, the lower jaw strongly projecting; maxilla extending to below center of eye, the upper-jaw length 2.25 (2.2–2.4) in head length; posterior end of maxilla with a distinct angular notch; dentition as in the genus. Tongue narrowly triangular with rounded tip, the upper surface with small papillae. Gill rakers well developed, the longest on lower limb nearly half orbit diameter in length. Anterior nostril a small, short, membranous tube on side of snout, slightly more than half distance from fleshy edge of orbit to median anterior point of upper lip; posterior nostril a narrow elliptical opening at level of upper

edge of pupil, its length about one-fourth pupil diameter.

Suborbital margin smooth, ending below center of eye; preopercular ridge slightly irregular, but without serrae; posterior three-fourths of ventral edge of preopercle and ventral half of posterior edge finely serrate.

Origin of dorsal fin over third to fourth lateral-line scales, the predorsal length 2.4 (2.4–2.5) in SL; first dorsal-fin spine 3.9 (3.45–4.05) in head length; second or third dorsal-fin spines longest, 1.9 (1.85–2.15) in head length; spine of second dorsal fin 2.3 (2.35–2.5) in head length; first dorsal soft ray longest (second ray nearly as long), 1.5 (1.45–1.5) in head length; first anal-fin spine very short, 7.75 (7.1–8.4) in head length; second anal-fin spine 2.8 (2.5–3.0) in head length; first anal soft ray longest (second ray nearly as long), 1.75 (1.45–1.8) in head length; caudal fin 3.1 (2.9–3.1) in SL; caudal concavity 3.05 (3.0–3.15) in head length; pectoral fins 1.5 (1.5–1.6) in head length, the third or fourth rays longest; pelvic fins reaching or extending slightly beyond anus, the first or second soft rays longest, 1.75 (1.65–1.85) in head length.

Color of holotype in alcohol pale yellowish on head and body, a little dusky dorsally on nape, along base of dorsal fins, and dorsally on caudal peduncle; a roundish black spot posteriorly on caudal peduncle slightly more than half pupil diameter in size; scattered melanophores on posterior half of caudal peduncle but



Figure 4. Holotype of *Zorania viridiventer*, BPBM 32507.



Figure 5. Underwater photograph of *Zorania viridiventer* taken at site where holotype was captured.



Figure 6. *Zorania viridiventer* at Karang Elmas Reef, Halmahera.

TABLE 3. Proportional measurements of type specimens of *Zoramia viridiventer* as percentage of the standard length.

	Holotype				Paratypes				
	BPBM 32507	BPBM 39077	BPBM 15627	BPBM 40155	BPBM 40155	BPBM 40155	BPBM 40155	BPBM 40155	BPBM 40155
Standard Length (mm)	39.2	31.3	33.9	35.6	37.5	38.0	39.8	40.4	42.3
Body depth	38.6	35.5	38.2	38.4	37.7	38.7	38.3	39.5	38.6
Body width	13.7	13.4	13.6	13.7	14.6	13.5	14.2	14.1	14.1
Head length	39.5	41.2	41.3	41.7	41.0	41.1	39.1	39.2	40.0
Snout length	10.1	10.2	10.0	10.6	10.3	9.8	9.8	9.9	9.8
Orbit diameter	14.8	16.0	15.5	15.4	15.0	14.6	14.8	14.5	14.2
Interorbital width	8.9	9.2	9.4	9.0	9.1	9.5	9.3	9.6	9.3
Upper-jaw length	17.5	17.5	18.3	17.1	18.6	18.7	17.6	17.4	17.8
Caudal-peduncle depth	16.4	15.7	15.9	16.1	15.9	15.0	15.7	15.8	15.8
Caudal-peduncle length	25.0	24.4	24.6	24.7	24.5	25.5	25.1	25.1	24.4
Predorsal length	41.5	40.0	41.8	40.7	41.0	41.4	39.9	40.1	39.6
Base of first dorsal fin	14.5	15.0	15.4	14.2	15.2	15.4	15.1	14.8	14.3
First dorsal spine	10.2	11.9	10.3	11.2	10.1	10.7	10.5	broken	10.6
Second dorsal spine	21.0	21.6	19.1	18.9	19.0	18.9	19.1	19.0	21.7
Third dorsal spine	20.8	21.3	21.1	19.3	18.7	18.7	18.8	18.7	21.0
Fourth dorsal spine	16.7	17.2	20.3	16.3	16.0	16.1	15.3	14.1	12.2
Fifth dorsal spine	11.6	12.5	12.7	11.4	11.6	12.1	11.3	13.8	10.9
Sixth dorsal spine	7.7	7.4	broken	6.7	7.8	7.6	7.7	7.2	7.1
Base of second dorsal fin	18.6	18.5	18.0	18.1	18.1	18.2	18.1	18.8	17.9
Spine of second dorsal fin	17.3	17.4	17.7	17.0	16.5	17.4	17.4	16.9	16.3
Longest dorsal ray	26.8	27.2	27.7	27.5	27.8	27.8	26.9	26.9	27.4
Base of anal fin	18.4	19.1	18.6	18.6	18.6	18.1	17.7	18.5	18.0
First anal spine	5.1	4.9	5.7	5.4	5.3	5.0	5.5	5.2	4.8
Second anal spine	14.2	15.9	15.1	14.4	14.0	13.9	15.1	13.0	15.8
Longest anal ray	22.9	27.9	broken	28.3	24.0	24.8	24.9	22.4	22.3
Caudal-fin length	32.3	34.5	broken	33.6	33.3	33.0	33.7	32.1	32.5
Caudal concavity	13.0	13.7	--	13.2	13.2	13.4	12.7	12.6	13.0
Pectoral-fin length	26.4	25.6	26.7	26.9	26.5	26.6	25.2	25.2	26.2
Prepelvic length	38.4	40.9	39.3	38.5	40.5	39.9	40.4	38.4	39.0
Pelvic spine	15.8	15.9	16.9	15.4	15.5	16.6	15.6	14.8	14.6
Pelvic-fin length	22.5	23.9	24.0	22.4	24.3	23.7	23.5	22.2	23.7

far less than the density dorsally on body: a faint broad dusky band on side of snout centered slightly below middle of eye; spines and rays of fins translucent yellowish, only the first two dorsal-fin spines and membranes a little dusky; remaining membranes of fins translucent; tips of caudal-fin lobes blackish (faint on lower lobe); the black digestive tract is visible as a faint dark area of the abdomen, becoming near-black as the intestine nears the anus.

Color of holotype when fresh as in Figure 4. The body other than the abdomen is translucent, making the vertebral column visible, and the small blue spots are apparent on the operculum and upper abdomen.

Figure 5 is from an underwater photo of an individual of this species taken at the collecting site of the holotype. The green area posteriorly on the abdomen often covers more of the abdomen, as may be seen in other underwater photographs such as those cited in the synonymy above.

The two fish of Figure 6 were photographed in 50 m at Karang Elmos Reef, Halmahera (0°10'1"N, 128°7'E); note the two vertical blue lines on the side above the pectoral fin.

Underwater photographs of aggregations of this species may show individuals with or without black tips on the caudal lobes. More often than not, at least the upper lobe shows a blackish distal end. As mentioned above, museum specimens often have abraded fins, especially the caudal, so black tips, had they been present, were lost.

ETYMOLOGY.— The specific epithet is a compound adjective from the Latin *viridis* for green and *venter* for abdomen, in reference to the green coloration usually present on the abdomen in life, at least in adults.

COMPARISONS.— *Zoramia viridiventer* differs from *Z. leptacantha* by lacking the dark line on the dorsum from the origin of the first dorsal fin onto the caudal peduncle. It also has a caudal spot that *Z. leptacantha* lacks. It differs from *Z. perlita* by lacking the dark lines just above the insertion of some of the anal-fin rays. It differs from *Z. gilberti* by lacking either a prominent or diffuse dark spot on the opercular flap. It differs from *Z. flebila* by lacking diffuse melanophores on the caudal peduncle in addition to the small caudal spot, and by usually having black tips on the caudal fin. Finally, it differs from *Z. fragilis* by having fewer gill rakers (24–27 verses 27–30), a shorter second dorsal-fin spine (18.9–21.7 verses 21.5–24.8), and a shorter second anal-fin spine (13.0–15.9 verses 15.1–17.9).

REMARKS.— We became suspicious that the material reported by Fraser and Lachner (1985) as *Apogon fragilis* Smith, 1961 might contain two species when we noticed the broad gap in the distribution of the species shown in their Figure 20 between the Seychelles and Sulawesi, and the broad range of the gill-raker counts of *A. fragilis* in their Table 4. Loans of paratypes of *A. fragilis* from Mozambique and specimens from Madagascar identified as *A. fragilis* by Fraser and Lachner provided a nearly complete separation of gill-raker counts from Pacific specimens (Table 2). This difference was reinforced by measurements that demonstrate that the second dorsal and anal-fin spines are generally longer in *Z. viridiventer* than in *A. fragilis*, as shown in our key.

We are not aware of any color photographs taken of *A. fragilis* when fresh or alive from the two localities for the species given by Smith (1961), Pinda, Mozambique and the Seychelles, or from the Madagascar locality reported by Fraser and Lachner. Smith included a painting of the species by Margaret Smith with his description of the species. It shows a pinkish-gray fish, becoming pale bluish gray on the abdomen, with a small black basicaudal spot, strong black stripe on the side of the snout and tip of lower jaw, a blackish line at base of the dorsal fins and dorsally on the caudal peduncle, black tips on the caudal lobes, and an orange line on the anal fin near the base.

Kuiter (1998:86) identified two underwater photographs from the Maldive Islands as *Apogon gilberti*, but neither is *Zoramia gilberti*. The single fish in the figure to the left could be *Zoramia viridiventer*, but without a specimen for study, we cannot be sure. The two fish in the figure to the right are gray with a broad iridescent blue-green stripe on the body at the level of the upper end of the gill opening, a very small black basicaudal spot, black-tipped caudal lobes, and a tiny black tip on the first dorsal fin. They appear to represent an undescribed species.

The distribution of *Zoramia viridiventer* is largely as given for the Pacific part of Fraser and Lachner's Figure 20 for *Apogon fragilis*: Philippines, Indonesia, Palau, Yap and Kapingamarangi in the Caroline Islands, southern Marshall Islands, northern Kiribati, Papua New Guinea, Great Barrier Reef, Solomon Islands, Vanuatu, and Samoa Islands. They reported the third author and associates' collections from Palau (in 1968), Marshall Islands, Solomon Islands, and Papua New Guinea. Randall et al. (2004) reported *Apogon fragilis* from Tonga, but the identification as *viridiventer* is questionable because of slightly higher gill-raker counts in the limited material available.

Hayashi (1980) placed *Apogon fragilis* in the synonymy of *A. gilberti* (Jordan and Seale), type locality, Negros. He reported *A. gilberti* from Ishigaki in the southern Ryukyu Islands; his black and white figure is not *A. gilberti* but appears to be *A. viridiventer*, in which case it would be the first record of the species from Japanese waters. We conclude the same for Hayashi and Kishimoto (1983) who reported *A. gilberti* from Iriomote Island in the Ryukyus.

Russell (1983) was the first to record this species from Australia (as *Apogon fragilis*). He listed two specimens, AMS I.18267-005 and I.18271-002, from One Tree Island, Capricorn Group,

southern Great Barrier Reef. The former was found at the Australian Museum by Mark A. McGroutner and Sally Reader, who reported it as "dried out beyond retrieval." The latter is a species of *Canthigaster*. The number Russell should have given was AMS I.18272-002, 45 mm SL. It is included above as one of the paratypes of *Zoramia viridiventer*, as is one lot from Lizard Island in the northern Great Barrier Reef.

This species is usually seen in aggregations in lagoons or bays, sheltering among branching corals, sponges, etc. Our collections have come from the depth range of 2–17 m, but as noted above, the species may be seen at least as deep as 50 m.

ACKNOWLEDGMENTS

We thank K.R. Longenecker and B.K. Mataitini for assistance in collecting specimens, and Captain B. Vasconcellos and the crew of the *Moku Moku Hine* for assistance in the field. We are grateful to J. Seeto, G.R. South, R.R. Thaman, and R.W. Tuxton of the University of the South Pacific, Fiji for facilitating our collecting in Fiji. We also thank the Fijian Government and local village chiefs for permission to collect fishes. We thank M. McGroutner and S. Reader of AMS and J.T. Williams of USNM for lending specimens. Special thanks to the staff at CAS for providing assistance: D. Catania, W.N. Eschmeyer, J. Fong, M. Hoang, and T. Iwamoto. The authors also appreciate the helpful comments of the anonymous reviewers. This research was supported by National Science Foundation grants INT97-29666 and DEB0-1027545, and Sea Grant Project R/FM-6PD.

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